Postings: from the desk of Jim Brodrick

This week, a special working group created by DOE and the Next Generation Lighting Industry Alliance published its long-awaited *LED Luminaire Lifetime: Recommendations for Testing and Reporting*. The working group is under the guidance of the SSL Quality Advocates oversight committee and is composed of a diverse group of experts in reliability, lighting, and LED technology. Their recommendations are a follow-up to a similar publication, *Reporting LED Luminaire Product Performance*, which focuses on initial performance criteria and product consistency and laid the groundwork for the Lighting Facts℠ label.

Despite all the progress that's been made in solid-state lighting over the past few years, defining the lifetime of LED products remains a murky area. Longevity is considered one of SSL's major advantages over traditional lighting technologies, and manufacturers are quite naturally touting it as a big selling point. But the topic is extremely complicated.

One of the problems is that it's impossible to directly measure the lifetime of a product that's expected to last for 50,000 hours or more. Why? Because 50,000 hours works out to nearly six years of continuous, 24/7 use, and SSL technology is changing so rapidly that any product is sure to be superseded by several generations of newer models before that much time has passed. This means that product lifetime has to be extrapolated rather than directly tested, which brings with it a whole new set of issues and uncertainties.

But an even thornier problem lies in figuring out just how to define the lifetime of an LED luminaire – since LEDs don't generally burn out like traditional sources, but instead emit a slowly diminishing amount of light over time. Although many manufacturers simply base their lifetime figures on the lumen maintenance values of the LED devices, that's misleading, because light degradation is only one component of a luminaire's reliability.

An LED luminaire is a complex system in which many other components also come into play, such as the driver, electrical connections, fixture housing, and optics. Problems with these other elements may sometimes lead to catastrophic failure, or may instead accelerate lumen depreciation. They have to be taken into consideration when describing product life, because a chain is only as strong as its weakest link – and it's quite possible that LEDs will not prove to be the weakest link in an SSL luminaire. So we need to gain a better understanding of all of the failure mechanisms that come into play with an LED luminaire – and we need an industry-wide process to drive us to that understanding.

Another problem in describing the lifetime of SSL products involves the metrics themselves. Generally, "L_{70}" is used to indicate the end of an LED luminaire's useful life – meaning the point in time at which lumen output has declined to 70% of the luminaire's initial output. This point was chosen because the human eye is not terribly sensitive to decreases in light levels of less than 30%, but for some critical applications, a higher figure could be used – such as L_{90}, indicating the point at which lumen output has depreciated only 10%. Similarly, a lower figure such as L_{50} could be used in applications where maintaining light level is of moderate importance.

Because there will be a distribution of failure times in any

product group, another metric, "B," is needed to say what fraction of the product has failed at the stated time – with "L_{70}/B_{50}", for example, indicating that 50% of the lamps in a given sample have reached 70% of the luminaire's initial output. For some applications, though, B_{50} may be too lax, in which case a more rigorous figure – such as B_{10}, the point where 10% of the lamps have failed – can be used instead.

But gradual lumen depreciation to L_{70} won't always be the cause of an LED luminaire's demise. As I said before, catastrophic failure of one of its other components may well occur first. That's why the lifetime working group recommends that a third metric, "F," also be used – with F_{10}, for example, indicating the point in time where 10% of the luminaires in a given sample have failed in a conventional sense. The recommendation is that when indicating a product's lifetime, the lower of the two metrics (L/B and F) be used. So, for example, if a luminaire's L_{70}/B_{50} point is 40,000 hours but its F_{10} point is 30,000 hours, its lifetime should be reported as 30,000 hours.

For some applications, such as retail lighting, an excessive shift in color could mean the end of a luminaire's useful life. While the working group's recommendations focus on defining lifetime strictly by lumen output, they also discuss the issue of color shift and conclude that in the near-term, while standards are still being developed, products should be segmented into one of three categories – lamp replacement, standard-grade luminaire, and specification-grade luminaire – with color shift treated differently for each category.

As for the Lighting Facts label, the working group recommends that it include product lifetime, when it has been demonstrated to a minimum level of confidence, in terms of L_{70}, B_{xx}, and F_{yy}. But this is not a requirement, since new products may not have

sufficient data to demonstrate lifetime. In such a case, the label can make no lifetime claim, or optionally include a warranty period. That warranty could cover either lumen lifetime, color shift, or both, depending on the needs of the product's market segment.

It's important to note that the recommendations published last week are only that – recommendations. The standards organizations will ultimately determine the details of measuring and reporting the lifetime and reliability of LED lighting products. The important thing now is to get everyone on the same page, speaking the same language. That's because it's essential that we all work together in our attempt to understand the issues surrounding true SSL lifetime and reliability. We've still got a long way to go, but these new recommendations are an important first step.

We recognize that they include a lot of compromises, and that there remain many issues that aren't fully understood. That's why we welcome your feedback, which will help us refine things even further. As always, you can send it – or any other comments – to me at postings@lightingfacts.com.